INEQUALITY, PRODUCTIVITY, AND CHILD LABOR: THEORY AND EVIDENCE*

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ABSTRACT

We extend the "general model" in Basu and Van (1998) to allow for different types of households, and the model in Swinnerton and Rogers (1999) to allow for a more general utility function. Our new finding is that while in higher-productivity countries with child labor, a more equal income distribution can reduce or eliminate child labor, in low-productivity countries, a more equal distribution of income can exacerbate child labor. Econometric specifications studying child labor among 10- to-14 year olds yield results broadly consistent with these predictions. This suggests that policy actions taken to reduce child labor should take into account the productivity level of the economy.

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1. Introduction

In June of 1999, by unanimous vote, the 174 member nations of the International Labor Organization passed an international convention on the worst forms of child labor (ILO, 1999a).[1] Upon ratification of this convention, member states are pledged by treaty to eliminate these practices immediately. An intent implicit in the convention is that countries would aim, in the long term, to end all forms of child labor.

One natural area of exploration is whether and under what conditions the goal of eliminating child labor is attainable, given resource constraints faced within individual economies. Another is: if there is to be aid flowing from countries who have eliminated child labor to those who have not, but this aid is limited, how is it to be targeted? These are the practical questions that face the international community in meeting the goals set out in its recent agreement about child labor.

In a path breaking paper, Basu and Van (BV: 1998) developed a theoretical framework that can be used to address many of these questions. BV focused on the question of when an outright ban on child labor could be an effective policy tool. Countries in which a ban could be effective were those that were well-off enough to be able to support all of their children without sending any to work (i.e., in which an equilibrium with no child labor coexisted with the equilibrium with some child labor). Only countries with relatively high labor productivity would fit this description.

[1]The new convention is meant to be complementary to other instruments aimed at child labor, or more generally, at improving the lives of children. These include ILO Convention 138 on the Minimum Age for Admission to Employment, and the United Nations Convention on the Rights of the Child.

In work that builds on a simple version of the BV framework, Swinnerton and Rogers (SR: 1999) showed that income inequality was related to a nation's child labor force participation. SR found that in precisely those circumstances where, according to BV, a ban on child labor would be effective, child labor exists because income is distributed unequally enough that some families still must send their children to work in order to sustain themselves. In those cases, a more equal distribution of income could be found for which child labor would be eliminated.[2]

This paper extends the model in SR by including a more general utility function. This very simple change in the model produces a striking finding: income redistribution will not aid in the elimination of child labor in economies with low labor productivity, and may in fact cause child labor to increase. While improving the income distribution raises incomes for the poorest part of the population, it also spreads a given amount of resources more broadly. These have opposite effects on child labor. In the lowest-productivity countries, the latter effect is stronger than the former: these countries may therefore be unable to rely on internal redistributive policies to address child labor.

The next section outlines the theoretical model, and introduces a graphical device for analyzing its comparative static properties. Section 3 shows that economies may react differently to equality in the income distribution, depending on their productivity. Section 4 presents an econometric model consistent with the theory, discusses data issues, and presents empirical results. Section 5 concludes and identifies some policy implications. A series of Appendices

[2]In related work, Ranjan (1999a,b) shows that credit constraints can be a cause of inefficient child labor. A redistribution, by relaxing credit constraints, would reduce child labor. Doepke (1999) explores another channel through which inequality could lead to increased child labor: when the skill premium is large, it is expensive for poor parents to send their children to school, so they send them to work instead.

prove the main proposition in the paper, and work though the analytical results.

2. The Model

We extend the “general model” in BV (1998) to allow for different types of households, and the model in SR (1999) to allow for a more general utility function. Output produced in the economy is a concave function of labor, and equals $f(L;R)$, with $Mf(L;R)/ML$, $Mf(L;R)/MR > 0$, $M^2f(L;R)/ML^2 < 0$, $M^2f(L;R)/MLMR > 0$ and $f(0;R) = 0$. R is a generalized productivity parameter that captures the effect of all non-labor-related inputs and total factor productivity. In keeping with BV’s *substitution axiom,* we assume one child produces (as much ((< 1) as an adult, so that the marginal productivity of 1/(children is equivalent to that of one unit of adult labor.

2.1 Labor Supply

There are N households of two types: those that receive “dividends” and those that do not. By using the term “dividends,” we do not mean to assert that households in developing countries have income generated by ownership of stock shares.   Rather, in our model, “dividends” are any output that is not earned by agents in the form of wages. Households in developing countries do vary in their access to non-labor income - - in cash or in kind.

The proportion of households receiving dividends is 8 (0 < 8 < 1). Dividends are split equally among these households. We will refer to higher 8s, implying that a larger fraction of households share equally in dividends, as a *more equal* distribution of dividends. In either type of household there are *m* children and one adult.[3] Adults are assumed to work full time. Children may or may not work: their labor supply is an outcome of the household’s utility maximization.

[3]Our results generalize when there are *x* adult workers per household. In this case, *m* represents children per adult worker.

Household utility is

$$U(c,E) = (C-S)(m-E) \quad (C \geq S)$$
$$= (C-S) \quad (C < S), \tag{1}$$

where E is the total amount of child labor supplied by the household, C is household consumption, and S is a subsistence level of household consumption. This way of modeling child leisure leaves open the possibility that parents do not treat all of their children equally, since what matters for household utility is the total amount of child leisure and not how it is distributed among the children. There is considerable evidence that in many countries parents do allow some children to specialize in child labor while others are able to acquire an education.[4]

Dividend households and no-dividend households face the budget constraint $w^A + \theta_i + w^C E_i \geq C$. w^A and w^C are, respectively, the adult and child wage rates, and the subscript i equals d for dividend-receiving households, and nd for households that do not: $\theta_{nd} = 0$, and $\theta_d \equiv [f(L;R) - L\frac{\partial f(L;R)}{\partial L}]/\lambda N$.

It is straightforward to show that a household's utility-maximizing child labor supply decision is, for $i = d, nd$,

$$E_i = 0 \quad if \quad w^A \geq S + mw^C - \theta_i \tag{2.1}$$

$$E_i = \frac{S + mw^C - w^A - \theta_i}{2w^C} \quad if \quad S + mw^C - \theta_i > w^A > S - mw^C - \theta_i \tag{2.2}$$

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[4]See, for instance, Psacharopoulos and Patrinos (1995), Chernichovsky (1985). Grootaert and Patrinos (1995) cite several studies that conclude that every child in a household is not equally likely to be in the labor force. Our model is not rich enough to determine which of a household's m children will enter the labor market first, but such a determination could be an interesting extension of our analysis.

$$E_i = m \quad if \quad w^A \leq S - mw^C - \theta_i \qquad (2.3)$$

Note from (2.2) that when E_i is not at a corner ($E_i = 0$ or $E = m$), then E_i is increasing in S and in m, and decreasing in w^A. Equations (2) verify that the model obeys BV's *luxury axiom*. As soon as total household income rises so that subsistence is achieved, households begin to remove their children from work. If household income from non-child-labor sources becomes sufficiently high, no child works at all.

There are four critical levels of the adult wage: for each type of household, there is one wage at which the household begins to send its children to work and another wage below which all of its children are working. These critical wage rates are listed and described in the first two columns of Table 1. The first wage listed in Table 1 is clearly the largest: no-dividend-household children are the first to enter the labor force, and they do so at a relatively high wage. The fourth wage listed is clearly the smallest: the child labor-force participation of dividend-household approaches 100% only at a relatively low wage. The two middle wages cannot be ranked *a priori*, leaving two possibilities. The first is that as the wage is decreased, all m children of every no-dividend household will be employed before the wage becomes low enough to induce *any* dividend-household children to work ($S - mw^C > S + mw^C - \theta$)[5]. For the remainder of this paper, we will refer to this situation as Case 1. The second possibility is that as the wage is decreased, *some* dividend-household children will begin to enter the labor force before *all m* no-dividend children are working (but labor supply per household will still be greater for no-dividend than for dividend

[5] θ in this condition is the level of dividends when all no-dividend children are employed, and none of the dividend children are. As shown below, aggregate labor supply in this case is $L = N[1+\gamma m(1-\lambda)]$.

households). We will refer to this as Case 2.

- Table 1 here -

We now turn our attention to the *aggregate* supply of labor. Every household supplies 1 + E_i units of labor (i = *d*, *nd*). Since firms are indifferent between hiring one adult or $1/\gamma$ children, firms view this household supply of labor as equivalent to $1 + \gamma E_i$ units of adult labor. The aggregate supply of (adult-equivalent) labor is, for every pair of wages w^A and w^C, the sum of labor supplied by the λN dividend households and the (1-λ)N no-dividend households:

$$L = N + \lambda N \gamma E_d + (1 - \lambda) N \gamma E_{nd}. \tag{3}$$

In Section 3 of this paper, we will explore how changes in the distribution of dividends (i.e., in λ) affect the aggregate supply of child labor. Table 1 implies that there may be as many as five distinct regions to the labor supply curve.[6] Moreover, while labor supply is continuous, it is not differentiable at all points. The upshot is that we will need to consider separately how dividends affect each region of the supply curve. We can greatly streamline this discussion by introducing a graphical representation of that curve.

We now develop the graph of the "equilibrium" labor supply curve. This curve is the aggregate supply curve (for adult-equivalent labor) that is implied by equations (2) and (3), with two additional equilibrium conditions incorporated into it. First, since firms are indifferent between adult and (appropriately-scaled) child labor, we impose the condition that $w^C = \gamma w^A$.[7] As shown in BV, if $w^C > \gamma w^A$, then children will never be employed, while if $w^C < \gamma w^A$, then

[6]As noted below, the critical wages in the last two rows of Table 1 may be negative for sufficiently high levels of dividends ($\theta > S$). If this happens, then the labor supply curve will have fewer than five regions.

[7] The wage axis on our graph represents the adult wage on the "ridge" of BV's "tilted Euclidean space."

adults will never be employed. Neither of these latter outcomes is relevant for examining child labor. The third column of Table 1 shows the critical wages for labor supply when w^{C} ' (w^{A}.[8]

The second thing we need to keep in mind in order to draw the equilibrium labor supply curve is that dividend-household labor supply depends on the size of dividends, which in turn depend on the total amount of labor used: $2 \; ' \; \frac{f(L;\mathrm{R})\&L\mathrm{M}f(L;\mathrm{R})/\mathrm{M}L}{8N}$. An equilibrium labor supply curve cannot be drawn under the assumption that dividends are constant, even though they are treated as constants by households when they decide how to involve their children in the labor market.

A device we use to facilitate drawing the equilibrium labor supply curve is first to set w^{C} ' (w^{A} in equations (2), and then to see how the critical wages for the *dividend* households vary with total labor supply L. Figure 3 graphs [S-2(L;R)]/(1-m() (the wage below which dividend-household children first begin to enter the labor force) and [S-2(L;R)]/(1+m() (the wage below which dividend-household children have a 100% participation rate) against L:

- Figure 1 here -

Both curves in Figure 1 have a negative slope, since M2/ML = - [LM^{2}f (L;R)/ML^{2}]/8N > 0. Their curvature depends on the third derivative of the production function.[9] Both curves have the same intercept on the L-axis (i.e., the L for which S = 2(L;R)). The curves have different vertical intercepts (when L = 2 = 0).

On the same set of axes, identify the levels of employment at which no children work, at

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[8] We assume that (m < 1, so that a household's children are less productive than its adults. If countries have an m that is high enough that children are more productive as a group than adults, then child labor will never be eliminated in those countries, for either type of household, regardless of how high the wage becomes.

[9]This curvature is inessential to any of our results.

which only dividend-household children work, and at which all children work, i.e., $L_G = N$, $L_M = N[1+(m(1\text{-}8)]$, and $L_B = N(1+(m)$.[10] We now can draw the equilibrium labor supply curve, using the curves in Figure 1 as a guide to determining when dividend-household children enter the market. This is done for Case 1 in Figure 2.

- Figure 2 here -

For $w^A > \frac{S}{1\&(m}$, total labor supplied, L, equals N. This is shown in Figure 2 as a vertical line at $L = L_G = N$, for adult wage rates above $\frac{S}{1\&(m}$. For convenience, we will refer to this segment of the labor supply curve as Region 1. For $\frac{S}{1\%(m} \# w^A < \frac{S}{1\&(m}$ (Region 2), no-dividend children begin entering the labor market. Their labor supply increases as w^A falls, so the labor supply curve is downward-sloping within this range of wages.[11] When $\frac{S\&2(L_M;R)}{1\&(m} \# w^A < \frac{S}{1\%(m}$ (Region 3), then $L \,'\, L_M \,'\, N[1\%(m(1\&8)]$: all no-dividend children are fully employed. Note that dividend-household children have not yet entered the market. Next, for $\frac{S\&2(L_B;R)}{1\%(m} \# w^A < \frac{S\&2(L_M;R)}{1\&(m}$ (Region 4), the wage is low enough to induce some dividend-household children to enter the labor market. The labor supply curve is downward-sloping within this range of wages. Finally, when $w^A < \frac{S\&2(L_B;R)}{1\%(m}$ (Region 5), then all dividend-household children are fully employed (as are no-dividend children).[12] The Figure-2 labor supply curve looks rather like the labor supply curve in SR, except that because of the utility function used here,

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[10] *G* for *Good*, *M* for *Middle*, and *B* for *Bad*, where we follow the convention started by BV of referring to zero child labor supply as "good" and 100% child labor supply as "bad". The precise location of these levels of employment will be one factor that determines whether a country's labor supply curve has a Case-1 shape or a Case-2 shape.

[11] The curvature of the supply curve is also inessential to our results.

[12] This Region probably has little empirical importance: the highest labor force participation rate for ages 10-14 reported by the ILO in 1990 was 58.7% (Burkina Faso).

it is continuous and it has negatively-sloped portions between the vertical segments.

Note, finally, that Figure 2 is drawn under the assumption that all five regions of the labor supply curve exist. Although Regions 1 through 3 certainly exist, (since the threshold wages $S/(1\&(m)$ and $S/(1\%(m)$ are positive for all L), Regions 4 and 5 may not exist if dividends are high enough to support subsistence for the households that receive them, i.e., if $S \& 2 < 0$ for some $L < L_B$. In this case, dividend children enter the labor market only when the market wage becomes negative, which cannot happen.

The equilibrium labor supply curve can be derived in the same way in Case 2, where $\frac{S\&2(L_M;R)}{1\&(m} > \frac{S}{1\%(m}$, so that dividend-household children begin to enter the market before labor force participation among the no-dividend children reaches 100%. There once again are as many as five distinct segments in the labor supply curve. Figure 3 shows what this curve looks like when all five regions exist.[13]

-Figure 3 here -

The main difference between Figure 2 (Case 1) and Figure 3 (Case 2) is that in the latter one Region 3 is a downward-sloping segment, reflecting the fact that dividend-household children have entered the labor market.

2.2 Labor Demand and Equilibrium

The labor demand curve is the usual competitive one:

$$w^A \; ' \; Mf(L;R)/ML \qquad (4)$$

This is a downward-sloping curve, since $M^2 f(L;R)/ML^2 < 0$. It shifts out with increases in productivity, R, because $M^2 f(L;R)/MLMR > 0$. Equilibrium exists when the labor demand curve

[13]Although existence of Regions 1 through 4 is assured by the fact that $S/(1\%(m)$ is positive, existence of Region 5 requires $S > 2(L_B;R)$, which need not always hold.

intersects the equilibrium labor supply curve, and the equilibrium is stable when the labor demand curve is flatter than the labor supply curve.

Such an equilibrium is possible in any of the regions of the labor supply curve, in Case 1 or in Case 2. In either case, there can be an equilibrium with no child labor (Region 1), and there can be an equilibrium with 100% child labor (Region 5). Multiple stable equilibria are also possible (i.e., situations where the labor demand curve intersects the labor supply curve from "below" in two places). This was a point stressed by BV. However, some configurations of multiple equilibria can be ruled out, as demonstrated by Proposition 1:

Proposition 1: If there is an equilibrium in which *none* of the dividend-household children are employed, then there cannot also be an equilibrium in which *any* dividend-household children are employed.

Proof: Appendix 1.

The intuition behind this result is the same as that in the model in SR: suppose there is an equilibrium in which no children are sent to work by households that receive dividends. If there were another equilibrium in which dividend-household children were employed, the economy would produce more than enough additional output to pay the children's wages. The remaining additional output would augment dividends. This implies that dividend household resources would be higher under the second equilibrium than under the first. But in that case, the household would wish to purchase more leisure for its children, which is a contradiction.

Proposition 1 tells us that no economy can have its labor demand curve intersect the labor supply curve both in a region of the supply curve in which there is dividend-household child labor and in a region in which there is not. This suggests that economies with dividend-household child labor may face different challenges in trying to curb child labor than do economies in which dividend-household children do not work. The next section of the paper confirms this: the comparative statics properties of the model depend on whether or not dividend children work.

3. Comparative Statics

3.1 Effect of an Increase in l

We now show how inequality (8) can affect child labor. Our conclusions do not depend particularly on whether Case 1 or Case 2 is the relevant case, so to fix ideas, we focus primarily on Case 1. Appendix 2 derives analytical results for the various regions of the labor supply curve, and also gives detailed results for Case 2.

Suppose 8 is increased, so that dividends become more equally-distributed. This has no effect on the labor demand curve. It has two effects on the equilibrium labor supply curve. First, it increases the number of dividend households (i.e., it reduces N[1+(m(1-8)]). This effect tends to reduce the amount of child labor among the newly-minted dividend households. Second, with more dividend households, any given level of profits will be spread out over a larger number of families. Therefore, 2 will fall, which will tend to increase child labor among dividend households. The net effect on the supply of child labor varies, for different regions of the supply curve. Figure 4 shows how:

- Figure 4 -

From Figure 4, it is clear that if a country is initially at an equilibrium in which dividend-household children do not work (i.e., if the labor demand curve intersects one or more of the labor supply curve's three upper regions), then employment (and child labor) could rise, fall, or remain the same. In Region 1, employment remains constant: the adult wage is high enough that even no-dividend households keep their children out of the labor force, so changes in the size and distribution of dividends are irrelevant. If equilibrium starts out in Regions 2 or 3 and remains there after the increase in 8, then child labor falls, due to the increase in the number of dividend households (which do not send their children to work). But if the increase in 8 is large enough, it could dilute dividends so much as to cause dividend households to begin to put their children to work.   If the original equilibrium was in Region 3, then child labor could rise.[14]   In Figure 4, for example, it is clear that labor supply increases at wages that start out at the bottom of Region 3.

At wage rates in Region 4, where dividend children are already employed, child labor will unambiguously increase. The increased labor supplied by dividend households outweighs any reduction due to increasing the number of dividend households. Finally, for wage rates in Region 5, distributing dividends more widely has no effect on labor supply or on child labor.

Case 2 is more straightforward. It can be shown that in Region 2, labor supply (and child labor) unambiguously decrease when 8 rises. In Region 3, labor supply is unaffected by a change in the distribution of dividend households,)8. In this region, the decrease in labor supplied by newly-minted dividend households, $2_1)8/2w^{A}$, is exactly offset by the increase in labor supplied by "old" dividend households. In this region,)8 acts like a lump-sum transfer of dividends from old dividend households to the newly-minted ones. Equation (2.2) shows that child labor supplies are linear in dividends for both types of households. Therefore, the lump-sum transfer does not affect the total supply of child labor. In Region 4, labor supply increases, and in Region 5, labor supplied is not affected. So for Case 2 we have that if the initial equilibrium did not feature dividend-household child labor (Regions 1 and 2), then child labor remains the same or falls as

[14]A wage rate that was originally in Region 3 would become a Region 4 wage rate.

inequality is reduced by making dividends available to more households. If the initial equilibrium did feature dividend-household child labor (Regions 3, 4, and 5), then child labor remains the same or increases.

Our general finding is that if dividend household children are not employed, then the effects of an increase in 8 are mixed: the supply of child labor could fall, rise (case 1 only) or remain constant. It remains constant if there already is no child labor (Region 1 of the labor supply curve). In economies with positive child labor, but none of it supplied by dividend-earning households, the increase in 8 will tend to reduce child labor, although it is possible in Case 1 that for a large enough)8, child labor could increase due to the dilution of dividends. The importance of this latter possibility is an empirical question. Since Case-1 economies have relatively high dividends,[15] they could well be economies that are rich enough to have $2 > S$. If so, then Regions 4 and 5 of the labor supply curve may not exist. The)8 that would be needed to dilute dividends sufficiently to induce dividend children to work, if it exists, would then be quite large. Such an increase in equality may be unlikely given the range of inequality that one sees in the data; leaving the sense that among sufficiently well-off economies, increasing equality may always be associated empirically with lower child labor.

Finally, we find that if any dividend household children are employed, then an increase in 8 will never reduce child labor: it could increase child labor, but (in Case 2, Region 3) it may have no effect at all. Thus, we find that the potential for eliminating child labor through a policy of redistribution of wealth exists, but only for economies that are wealthy enough that wealth-holding families do not send their children to work. For other economies, redistribution may exacerbate

[15]The condition that defines Case 1 can be re-written as $2(L_M;R) > 2(mS/(1\%(m)$.

the problem of child labor.

3.2 Other Comparative Statics Results

An increase in productivity is an increase in R. An increase in productivity affects the supply side of the labor market through its effect on dividends. By raising dividends, an increase in productivity reduces child labor in those equilibria in which dividend-households had their children at work. On the demand side, the increase in R shifts out the demand curve for labor. If the demand curve intersects the supply curve in a downward-sloping portion (and the equilibrium is stable), then the demand-side effect is also to reduce child labor. In general, an increase in productivity reduces child labor, although in Region 4 there are both demand and supply effects, while the reduction in Region 2 is due to labor demand effects alone.

Note that since labor demand shifts upward when R (productivity) increases, there is a critical value of R such that for higher values of R, increases in 8 will be associated with non-positive changes in child labor. For lower values of R, increases in 8 will be associated with non-negative changes in child labor. We will refer to economies with equilibria in the first (second) instance as “high-productivity” (“low-productivity”) ones.[16]

Child labor is also affected by the ratio of children to adults, *m*. If m increases, then all of the threshold wages rise, with the result that child labor supplied unambiguously increases.

[16]The only ambiguity in this taxonomy occurs in the case where a high-productivity economy has multiple equilibria, with one equilibrium at the bottom of Region 3. The two equilibria may react with opposite signs in response to a change in 8. Empirically, if we observed this economy in a Region 3 equilibrium, we might classify it as a low-productivity economy, whereas if we observed it in Regions 1 or 2 we would classify it as high productivity.

4. Empirical Evidence

4.1 Econometric Model

Our theory suggests that three equilibrium outcomes–aggregate child labor supply (*E*^c^), labor demand (*L)*, and profits *(*B*)* or dividends--are determined endogenously. The structural econometric equations are:

E^c^ = "~0~ + "~1~*w*^A^ + "~2~B + "~3~*m* + "~4~8 + ,~1~;   "~1,~ "~2~ < 0, "~3~ > 0, "~4~ ? (5)

L = $~0~ + $~1~*w*^A^ + $~2~R + ,~2~; $~1~ < 0, $~2~ > 0 (6)

B = J~0~ + J~1~*L* + J~2~R + J~3~*w*^A^ + 0~3~;   J~1~, J~2~ > 0, J~3~<0 (7)

The 0~i~ are assumed to be classical error terms. In (5), the coefficient on inequality, "~4~, is non-positive in a "high" productivity economy, and non-negative in a "low" productivity economy.[17] In specifying child labor as depending only on wages, profits, children per adult worker, and inequality, we are implicitly assuming that the subsistence level of household consumption, *S*, and the relative efficiency of child workers, γ, are constant across countries.

Two identities are needed to derive the reduced form of the model. Maintaining our assumption of full employment of adults (so that *E*^A^ = 1), these are:

L^C^ / *(L-1)/*((8)

E^C^ / *L*^C^ (9)

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[17]Strictly speaking, there is also a theoretical ambiguity in the sign of *"~1~*. If the children supported by one adult worker can provide more than one unit of adult-equivalent labor ((*m* > 1) and aggregate profits in the economy are enough on their own to potentially support everyone without recourse to child labor (*B* > *NS*), then *"~1~* > 0. We believe that these conditions are unlikely to be satisfied empirically. Higher profits in an economy are likely to be associated with higher overall income levels, which in turn are likely to imply higher levels of education among adults and lower fertility. Higher education among adult workers suggests a greater productivity differential between adult workers and relatively uneducated child workers, i.e., a lower value of (, and lower fertility implies lower *m.*

(8) says that the demand for child labor is the labor demand not satisfied by the employment of adults. (9) is the equilibrium condition that child labor supply equals demand.

The system (5) through (9) defines three reduced form equations in which the endogenous variables E^C, w^A, and B are each related to the exogenous variables R, 8, and m. Of these three equations, we are concerned with the one that shows how the employment of child labor depends on the exogenous variables, particularly 8:

$$E^c = *_0 + *_1 R + *_2 m + *_3 8 + < \tag{10}$$

The slope parameters of (10) are related to the parameters of (5) through (7) in the following way:

$*_1 = (\$_1 - ()["_1 + "_2\$_2(J_1\$_1 + J_3)/\$_1 + "_2(J_1\$_2 + J_2)]/\$_1 < 0$,

$*_2 = (\$_1 - ()"_3 /\$_1 > 0$, and

$*_3 = (\$_1 - ()"_4 /\$_1$?

We expect child labor to decrease as an economy becomes more productive (i.e., as R increases), and to increase if more children are supported by each adult worker (i.e., as m increases). $*_3$ takes the same sign as $"_4$: in a low-productivity economy it is predicted to be non-negative, indicating that more inequality may lead to less child labor. In a high-productivity economy it is predicted to be non-positive, so that a reduction in inequality may bring about less child labor.

4.2 Data and Methods

Our unit of observation is a country in 1990. The explanatory variables in equation (10) are "productivity (R)," children per adult worker (m), and "inequality (8)." Our measure of R is real GDP per worker (RGDPW) in thousands of 1985 international dollars, from the *Penn World Tables Mark VI*. Using the ILO's (1997) *Economically Active Population (EAP)* electronic database of estimates and projections, we constructed a measure of m (CHILDADU) as the ratio of the number of children under 15 to the economically active population aged 15 and over.

8, the percentage of households that share in non-labor income (our measure of inequality), cannot be measured directly for the majority of countries for which income distribution data are available. We proxy this variable with two alternative measures of inequality that are standard in the applied literature: "raw" GINI (RAWGINI) coefficients, and "raw" measures of the ratio of the share of income accruing to the top fifth of the distribution to that accruing to the bottom fifth (RAWQ5Q1). Both measures are taken from the "high-quality" data set of Deininger and Squire (DS, 1996). The inequality measures for any country in that data set were based on either expenditures or on income, depending on what type of high-quality survey was available.[18] Inequality measures are not available for 1990 for every country. To increase the size of our sample, we sometimes used inequality measures from within 5 years of 1990. There is little variation in these measures in the short term. It should be noted that the direction of increasing inequality with these measures is opposite to that of our theoretical parameter 8. Higher RAWGINIs or RAWQ5Q1s imply more inequality. Thus, the prediction on the sign of the coefficients on the inequality variable are reversed when using these empirical measures.

Both RAWGINI and RAWQ5Q1 are measures of income inequality for countries for which inequality derives from more than one source (eg., from the distribution of non-labor income as well as from wages). Therefore, neither of our inequality proxies is an exact match for our inequality variable, 8. Taking our model literally, there is still a relation between the GINI implied by our model and 8. It is straightforward to show that the GINI coefficient implied by our

[18]Expenditure-based measures, which typically are the only kind available for the lowest-income countries, usually show less inequality than income-based measures. DS (1996) discuss methods for adjusting these data so that income measures and expenditure measures are more directly comparable. Making those adjustments made no notable change to the empirical results we report below; therefore, we do not report empirical results generated using the adjusted measures. The results are available upon request.

model is $GINI = 1 - \lambda - \mu$, where μ is the share of income earned by the non-dividend households. It is generally the case when the proportion of no-dividend households falls, that even though the aggregate share of income accruing to the remaining no-dividend households also falls, the GINI rises.[19]

The ratio of the share of income accruing to the top fifth of the distribution to that accruing to the bottom fifth is often used in the applied literature on inequality to check on the robustness of results found using the GINI. We will follow the literature and use it here for that purpose as well. We note that in our model, $Q5{:}Q1 = (1-\lambda)(1-\mu)/\lambda\mu$.

The most appropriate measure of child labor available is the economically active participation rate for children 10 to 14 years old (EAP90).[20] We use estimates taken from the *EAP* database which have been adjusted by the ILO to be "as comparable as possible" across countries (ILO, 1996). The database presents estimates or projections for EAP rates for every fifth year starting with 1950 and going up to 2010. We use 1990 data because this is the most recent year for which the database contained primarily estimates instead of projections.[21]

A special issue arises in the use of the EAP data for 10 to14 year olds. In several countries, the legal age for working is 15 or older, and the country's labor force survey does not

[19]The only instance when we are unable to verify that increases in λ imply decreases in GINI is when changes in equilibria involve region 4 of our labor supply curve. We note however that our empirical results below are generally consistent with the conclusion that there is an inverse relationship between λ and GINI, even in this region.

[20]Rates for younger children are generally not available.

[21]Each year the ILO publishes yearly estimates of EAP rates in its annual *Yearbook of Labour Force Statistics*; however, in the *Yearbook* the rates reported are raw in that they come directly from each country's labor force survey or census and have not been adjusted for cross-national comparability.

collect work-related information on children under that age. The EAP database reports EAP rates of zero for 10-to-14 year-old children in these countries. There is some question as to how to treat these observations. On the one hand, the zeros could be interpreted as "missing values" and these observations could be discarded. However, this is likely to lead to biased estimates if the zero rates reflect reality in those countries. The vast majority of countries for which zeros are reported are wealthier, more developed ones, i.e., ones classified by the World Bank as class three ("upper-middle income") or four ("high income"). Since the presumption amongst most experts on child labor is that child labor falls as poverty eases (U.S. Department of Labor or USDOL, 2000), we treat these zero values as censored data points. That is, if the EAP rates in the wealthier countries are not actually zero, we assume that they are close enough to zero to round to zero. Accordingly, we use Tobit estimation when EAP90 is specified as the dependent variable.[22]

There are also some countries in which the minimum age for labor force participation data is older than 10 but younger than 15. This does not lead to complete censoring of the EAP90 variable because non-zero values are reported. However, in these cases the data presented by the ILO are not technically EAP rates for 10 to 14 year olds. Rather, they are the number of economically active children in the age range for whom activity information is available as a proportion of all children 10 to 14 years old.[23] There is likely to be underestimation of EAP rates in these cases. Two ILO publications, *Statistical Sources and Methods*, and *Sources and Methods Labour Statistics*, present the minimum age for questioning about economic activity participation in, respectively, labor force surveys and population censuses. Using these sources

[22]These censored observations make up about one third of our overall sample.

[23]Electronic Correspondence dated February 11, 2000 with Farhad Mehran of the ILO Bureau of Statistics (Geneva).

(for various years) and consulting with officials at ILO's Bureau of Statistics, we were able to identify the initial source for EAP data (survey or census) for each country in our sample and the minimum age at which data on the participation status of children was collected. In our data set the variable QUESAGE records this minimum age, and we include this variable as a control variable in our specifications that use EAP90 as the dependent variable.

As a double check of our results using EAP90 as the dependent variable, we present specifications that take gross secondary school enrollment rates (GROSSSEC) or gross primary school enrollment rates (GROSSPRI) as the dependent variable.[24] The thinking behind this is that there should be a strong inverse correlation between these variables and child labor, because if children are working they are less likely to have time to go to school.[25] In our data, the correlation coefficients between EAP90 and GROSSSEC or GROSSPRI are, respectively, -0.83 and -0.79 when zero EAP90 values are included, and -0.91 and -0.78 when they are not.[26] The school enrollment data were taken from the World Bank's (1998) World Development Indicators CD-ROM.[27]

The maximum size of any sample we use is 88. The criteria for including a country in the

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[24]A gross enrollment rate is the number of children in a certain level of schooling over the number of children of *usual age* for that level of schooling in a population. Because the ages of children in the numerator can diverge from the ages of children in the denominator, gross enrollment rates can exceed 100 percent.

[25]USDOL (2000) contains a detailed discussion of this assumption.

[26]USDOL (2000) reports correlation coefficients of -0.82 and -0.58. Their estimates exclude observations with zero participation rates. Compared with our estimates making this exclusion, theirs are based on larger samples.

[27]A companion volume to the CD contains a discussion of the well-known measurement issues that arise in the collection of these data.

sample was our ability to obtain EAP90, RGDPW and RAWGINI data for that country. Specifications using the other inequality measure, RAWQ5Q1, or the other proxies for child labor, GROSSSEC or GROSSPRI, rely on smaller samples because of additional missing values among those variables.

Turning now to the methodology for estimation, recall that our theory predicts that the effect of changes in inequality should differ in sign in "low" versus "high" productivity countries. Thus, we should allow for different parameter estimates among these countries. Since in this context it is an empirical question as to what is the dividing line between low and high productivity, we use Quandt's method for estimating a deterministic switching regression model with an unknown switch point (Goldfeld and Quandt, 1976). The outcome of this estimation procedure is an estimate of (10) for low productivity countries, an estimate of (10) for high productivity countries, and an estimate of the level of RGDPW that determines the switch point between high and low productivity.

In addition to the tests conducted to determine the significance of the coefficients generated by the specifications for low and high productivity countries, it is desirable to test for the existence of the switch point between the two. The null hypothesis specifies no switch, so that a failure to reject this hypothesis implies that only one equation should be estimated for the entire data set. Unfortunately, no completely satisfactory method for conducting this test has ever been developed. The most straightforward approach, a likelihood ratio test, suffers from the fact that the usual test statistic for conducting this test does not have an exact Chi-square distribution (Quandt, 1960). However, Goldfeld and Quandt (1976) describe Monte Carlo simulations that suggest that using the likelihood ratio test works reasonably well. They, and Farley, Hinich and McGuire (1975), also review a number of alternative testing procedures, each of which has some potentially undesirable property. In our tests for a switch point in the data, we employ the likelihood ratio test and at least one other of these methods as a double check.

As described above, when EAP90 is the dependent variable the coefficients are Tobit estimates. Censoring is not an issue with GROSSSEC or GROSSPRI, so if either of these is used as the dependent variable OLS coefficients are estimated. General tests for heteroscedasticity were conducted and, where necessary, standard errors were corrected using White's correction.

4.3 Results

Results are presented in Tables 2 through 4 for specifications with, respectively, EAP90, GROSSSEC, and GROSSPRI as the dependent variable. Each table contains three horizontal and two vertical panels. The upper-most horizontal panel presents the results of the empirical model when run on the entire sample.[28] The lower two panels present results for lower- and higher-productivity countries respectively. These two panels will be the focus of our discussion. Between these two panels, the RGDPW that defines the split point is reported. The Chi-Square value for testing for the existence of a switch point is presented at the bottom of the table. The vertical panels, numbered (1) and (2), differ in the measure of inequality.   In panel (1) it is RAWGINI; while in panel (2) it is RAWQ5Q1.

– Table 2 here --

Starting with panel (1) of Table 2, we note that the signs of the coefficients for RAWGINI in the lower and upper sub-samples are consistent with our theory. In the lower sub-sample--countries with RGDPW of less than $5020-- more inequality (a higher RAWGINI) is associated with less child labor. In the upper sub-sample–countries with RGDPW of $5020 or more-- the

[28]Using a sample of 51 countries, Ranjan (1999b) finds both GINI and ratio measures to be significantly and inversely related to child labor.

coefficient is positive, so that more inequality is associated with more child-labor. The RAWGINI coefficient is significant only in the upper sample. This is not wholly unexpected. Our theory suggests only that whether or not the relationship between child labor and RAWGINI in low-productivity countries should be non-positive, so that the insignificance of the coefficient on RAWGINI in the lower sub-sample is itself consistent with theoretical predictions.

Three other results from panel (1) are worthy of discussion. First, the coefficient on RGDPW has the expected sign in both sub-samples, but is significant only in the lower sub-sample. Since the coefficient on RAWGINI is significant in the upper sub-sample, this could be a verification of the conclusion in Swinnerton and Rogers (1999) that in high-productivity countries only inequality matters as a cause of child labor. Second, the QUESAGE variable is negative and significant, suggesting that there is substantial underestimation in some of the ILO's reported EAP rates caused by differing ages of first questioning for activity status, and that our inclusion of this variable makes an important adjustment. Finally, the Chi-Square statistic for testing for the presence of a switch point is 58.85, well in excess of the 15.51 value needed to reject the hypothesis of no split at the five percent level.

The results in panel (2) of Table 2, where RAWQ5Q1 is used instead of RAWGINI as the inequality measure, contain two notable differences when compared with panel (1). First, the RGDPW at the switch point between the two sub-samples ($10,010) is almost double the value of switch RGDPW estimated in panel (1). Second, the coefficient on the inequality variable is positive and significant at the10 percent level in the lower sub-sample, suggesting that increases in inequality are associated with increases in child labor in low productivity countries.

It is unclear why changing the inequality measure should make so much of a difference in the location of the switch point, but we believe the switch identified in panel (2) is at too high a level of RGDPW. None of the other five estimates in Tables 2 through 4 place the switch point at a level of RGDPW anywhere close to $10,010. It should be noted that if the split point is at too high a level of RGDPW, the coefficient on RAWQ5Q1 in the lower sub-sample is also suspicious. If enough high-productivity countries have been mistakenly included in the lower sub-sample, they could have seriously biased the estimate of this coefficient, even reversing its sign.

We turn now to our estimates that use gross enrollment rates as the dependent variable. Since these are negatively related to EAP90, our predictions about the signs of the coefficients should all be reversed relative to when EAP90 is the dependent variable.

– Table 3 here --

In panel (1) of Table 3, we see that the results when RAWGINI is the inequality measure and GROSSSEC the dependent variable are broadly consistent with our theory and our results in Table 2. In particular, higher levels of inequality are associated with lower secondary school enrollment in higher productivity countries (here identified as those with RGDPW of $2400 and above). This result is significant at better than the 10 percent level.[29] In lower productivity countries the point estimate on RAWGINI suggests the opposite relationship, but the result is not significant. Higher RGDPW implies higher school enrollment in both sub-samples. The most notable difference between Table 2 and Table 3 is that in the latter the number of children per adult worker (CHILDADU) has a significant effect. As our theory would lead us to believe, the more children supported per adult worker, the lower the secondary school enrollment rate. The point estimates in panel (2) of Table 3 tell a similar story to those in panel (1). However, the

[29]The p-value is 0.0745.

coefficients on the inequality measure (RAWQ5Q1) are statistically insignificant.[30]

– Table 4 here - -

The general story that emerges from Table 4, where the dependent variable is GROSSPRI, differs from that of the earlier tables. The coefficient on the inequality variable is not significant in any of the sub-samples in the table. The coefficient on RGDPW is significant only in the lower sub-sample when inequality is measured by RAWGINI. CHILDADU is significant in both of the lower sub-samples. No individual coefficients obtain significance in the upper sub-samples. In fact in the upper sub-samples, the coefficients are also jointly insignificant.[31]

We do not view the results in Table 4 as generally troubling for our theory. But we do think that they suggest that we should perhaps think differently about child labor among younger versus older children. One issue may be simply data. Primary school enrollment rates may not be a very good proxy for child labor among younger children, particularly if parents who do allow their younger children to work ensure that work be structured so that their children can also go to school. This thought also has implications for how we view household decision making. Basu and Van's (1998) luxury axiom, which we maintain throughout our theoretical work, suggests that

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[30]It should also be noted that the results presented in panel (2) of Table 3 are for the split of the overall sample with the third highest likelihood value. The reason for this is not precisely related to our earlier discussion of the results in panel (2) of Table 2. Rather, it is because the two specifications with the highest likelihood values in the present case were the ones with the smallest number of possible observations (6) in either the lower or upper sub-sample. In a simulation exercise, Quandt (1958) shows that it is not unlikely for his procedure to identify several local maxima for the likelihood function, which include splits of the sample for which either of the regressions has very few observations. He views the behavior of the likelihood function at these extremes as "irregular," but "not unexpected in view of the fact that at the extremes the estimates of the error variance are based on very few observations." (p. 879)

[31]For the upper sub-sample in panel (1), the F-statistic = 1.62; for panel (2), 1.01.

parents withdraw children from work as the basic necessities of the household are met. But if primary education is considered a basic necessity of the household and of the child, then meeting this need necessarily means limiting the time potentially available for work. Accordingly, the predictions made by theory that relies on the luxury axiom may be diluted. Examination of our empirical results in Tables 2 and 3 cause little pause on this score for children older than 10, but Table 4 suggests that a different way of thinking about child labor among younger children may be worthy of exploration.

5. Conclusions

Our theory suggests that among those economies with child labor, those with relatively high productivity may reduce child labor by seeking a more equitable distribution of income.[32] In those economies, there is more than enough aggregate income to eliminate child labor, and child labor exists largely because the distribution of income is sufficiently unequal. In low-productivity economies, the theory suggests that such redistribution may be ineffective and can even have the perverse effect of increasing child labor. In these economies, only the highest-income families may be able to survive without child labor; and, even those families may be just on the margin of survival. An equalizing redistribution could lower the income of the highest-income families so that their children must work, without raising any other family's income by enough so that they can pull their children out of work. Our empirical results for 10-to-14 year old children are broadly consistent with our theoretical predictions. A practical question, then, is what level of

[32]While the theory technically addresses income distribution, we believe the results are valid when interpreted more generally as the distribution of all resources in the economy, including those distributed as private income and in terms of publicly-provided goods such as public schooling.

productivity marks the dividing line between "high" and "low" productivity economies? Based on our empirical results, we suggest that a real GDP per worker of $10,000 (in 1985 international dollars) is a conservatively high estimate.

Our results have implications for policy. Many commentators on child labor, including ourselves (Swinnerton and Rogers, 1999), have expressed the sentiment that "[g]eneral economic development, equitably distributed, is the best and most sustainable way of reducing child labour." (Grootaert and Kanbur, 1995, p. 198). The results of our research suggest some refinement may be needed to make this prescription more precise contextually. In low-productivity countries, the major policy emphasis should probably be on productivity growth with little or perhaps even no emphasis on equity.[33] In higher-productivity countries with child labor, more weight should be given to equity-inducing policies.

This research is also relevant to the activities of the most prominent international effort working toward the elimination of child labor in the world today, the ILO's International Program on the Elimination of Child Labor (IPEC). IPEC's strategy is to motivate "a broad alliance of partners to...act against child labor." In choosing governments as partners, IPEC seeks those with the "political will and commitment...to address child labor in cooperation with...relevant parties in society..." (ILO, "IPEC at a Glance").

Clearly, political will must encompass, or be matched with, the economic means to take child-labor-reducing actions. Practically, IPEC serves as a mechanism for wealthier countries to donate resources to set up child-labor-reducing programs in less well off countries. IPEC hopes

[33]This statement relates only to child labor concerns and need not be appropriate to a host of other competing concerns that may affect policy decisions in these countries, nor is it meant to exclude equity-inducing policies if they also have the effect of raising productivity.

these programs will serve as examples to the recipient countries, and others, of actions they can continue to take to address child labor, *without* the long-term financial support of IPEC and its donors (USDOL, 2000). If the resources for the sustained reduction of child labor must at some point come solely from within an economy with child labor, the question of whether sufficient resources exist within that economy becomes particularly germane. In higher-productivity countries with child labor, our research suggests that the resources may be there, and that given IPEC's goals to encourage local action, choosing among this group of countries the ones with the political will to act may be an efficient way of targeting IPEC's resources. Our research also suggests however that IPEC's strategy may not be particularly workable in low-productivity countries, unless it can be adapted to longer-term horizons. Longer-term and sustained transfer of resources to these economies from wealthier ones are likely to be necessary before they even reach the point where they will be able to deal with their remaining child labor problems on their own.

APPENDIX 1: PROOF OF PROPOSITION 1

Proposition 1: If there is an equilibrium in which none of the dividend-household children are employed, then there cannot also be an equilibrium in which any of the dividend-household children are employed.

Proof: By contradiction. Suppose an equilibrium exists in which none of the dividend-household children are employed, and let L^* stand for total employment in this equilibrium. Then,

$$\frac{\partial f(L^*;R)}{\partial L} \geq \frac{S-\theta(L^*;R)}{1-m^*}, \text{ or}$$

$$\frac{f(L^*;R) + \frac{\partial f(L^*;R)}{\partial L}[\lambda N(1-m^*)-L^*]}{\lambda N} \geq S, \tag{A1.1}$$

where we have made the obvious substitution for $\theta(L^*;R)$.

If another equilibrium with $L^{**} > L^*$ <u>also</u> exists in which dividend-household children are employed, then in this equilibrium,

$$\frac{\partial f(L^{**};R)}{\partial L} \leq \frac{S-\theta(L^{**};R)}{1-m^*}, \text{ or}$$

$$\frac{f(L^{**};R) + \frac{\partial f(L^{**};R)}{\partial L}[\lambda N(1-m^*)-L^{**}]}{\lambda N} < S. \tag{A1.2}$$

(A1.1) and (A1.2) imply the following necessary condition for L^* and L^{**} to co-exist as multiple equilibria:

$$\frac{f(L^*;R) + \frac{\partial f(L^*;R)}{\partial L}[\lambda N(1-m^*)-L^*]}{\lambda N} > \frac{f(L^{**};R) + \frac{\partial f(L^{**};R)}{\partial L}[\lambda N(1-m^*)-L^{**}]}{\lambda N}, \text{ or,}$$

$$\frac{\partial f(L^*;R)}{\partial L}[\lambda N(1-m^*)-L^*] - \frac{\partial f(L^{**};R)}{\partial L}[\lambda N(1-m^*)-L^{**}] > f(L^{**};R) - f(L^*;R) \tag{A1.3}$$

Concavity of the production function implies

$$f(L^{**};R) - f(L^*;R) > \frac{\partial f(L^{**};R)}{\partial L}(L^{**} - L^*)$$

Therefore, we can re-write the inequality (A1.3) as

$$\frac{\mathrm{M}f(L^{(};\mathrm{R})}{\mathrm{M}L}[8N(1\&m(\,)\&L^{(}]\&\frac{\mathrm{M}f(L^{((};\mathrm{R})}{\mathrm{M}L}[8N(1\&m(\,)\&L^{((}] > \frac{\mathrm{M}f(L^{((};\mathrm{R})}{\mathrm{M}L}(L^{((}\&L^{(})$$

With some algebra, we get

$$[8N(1\&m(\,)\&L^{(}][\frac{\mathrm{M}f(L^{(};\mathrm{R})}{\mathrm{M}L}\&\frac{\mathrm{M}f(L^{((};\mathrm{R})}{\mathrm{M}L}] > 0 \tag{A1.4}$$

The first term in square brackets is negative: N # L*, and 8 and (1-m() are fractions. Therefore, the second term must also be negative in order for the inequality (A1.4) to hold. But Mf(L*;R)/ML > Mf(L**;R)/ML, so this is a contradiction.

APPENDIX 2: ANALYTICAL RESULTS

The Equilibrium Labor Supply Curve

Define L_G = N, L_M = N[1+(m(1-8)] and L_B = N(1+(m).

Case 1: $S/(1\%(m) > [S\&2(L_M;R)]/(1\&(m)$. All m children of every no-dividend household are working before any dividend-household child enters the market. The labor supply curve has up to five regions:[34]

Region	Range for w^A	Labor supply
1	$\left[\frac{S}{1\&(m}, 4\right)$	N
2	$\left[\frac{S}{1\%(m}, \frac{S}{1\&(m}\right)$	$N\%(1\&8)N\frac{S\&(1\&(m)w^A}{2w^A}$
3	$\left[\frac{S\&2(L_M;R)}{1\&(m}, \frac{S}{1\%(m}\right)$	$N[1\%(m(1\&8)]$
4	$\left[\frac{S\&2(L_B;R)}{1\%(m}, \frac{S\&2(L_M;R)}{1\&(m}\right)$	$N[1\%(m(1\&8)]\%N8\frac{S\&(1\&(m)w^A\&2(L;R)}{2w^A}$
5	$\left[0, \frac{S\&2(L_B;R)}{1\%(m}\right)$	$N(1\%(m)$

It is straightforward to verify that the labor supply curve is continuous, and that the labor supply curve has a negative slope in Regions 2 and 4.

Case 2: $\boldsymbol{S/(1\%(m) < [S\&2(L_M;R)]/(1\&(m)}$. Dividend-household children enter the market before all m no-dividend children are working. This labor supply curve also has as many as five regions:

Region	Range for w^A	Labor supply
1	$\left[\frac{S}{1\&(m}, 4\right)$	N

[34] If $S < 2$, then Regions 4 and 5 do not exist in case 1 (i.e. they exist only for negative wages). In this case, all of the analysis of this appendix goes through, except that the regions that do not exist should be ignored.

2	$\left[\frac{S\&2(L;R)}{1\&(m},\ \frac{S}{1\&(m}\right)$	$N\%(1\&8)N\frac{S\&(1\&(m)w^{A}}{2w^{A}}$
3*	$\left[\frac{S}{1\%(m},\ \frac{S\&2(L;R)}{1\&(m}\right)$	$N\frac{S\%(1\%(m)w^{A}}{2w^{A}}\&8N\frac{2}{2w^{A}}$
4	$\left[\frac{S\&2}{1\%(m},\ \frac{S}{1\%(m}\right)$	$N[1\%(m(1\&8)]\%N8\frac{S\&(1\&(m)w^{A}\&2(L;R)}{2w^{A}}$
5	$\left[0,\ \frac{S\&2(L;R)}{1\%(m}\right)$	$N(1\%(m)$

This labor supply curve also is continuous, and has a negative slope within Regions 2, 3*, and 4. Algebraically, Regions 1, 2, 4, and 5 are similar in Case 1 and in Case 2. Region 3, however, differs across the two cases. We therefore use the symbol “3*” to denote Region 3 in Case 2.

Changes in the Labor Supply Curve

Effect on the Labor Supply Curve of an Increase in 8 ()8 = 8_1 - 8_0 > 0)

An increase in 8 changes the relative proportions of dividend and no-dividend households and also reduces the level of dividends received by each household. The latter effect implies that a wage that starts out in one Region of the labor supply curve may be in another Region following the change in 8. In what follows, we use the notation 2_0 and L_0 to stand for dividends and labor supplied when $8 = 8_0$, and 2_1 and L_1 to stand for dividends and labor supplied when $8 = 8_1$.

Case 1: $S/(1\%(m) > [S\&2(L_M;R)]/(1\&(m)$

Figure A1 shows some of the ways Regions may switch. The line labeled (i) is our starting point: it shows how the regions of the labor supply curve are related to the wage when $8 = 8_0$, and is drawn so as to be consistent with Case 1. The line labeled (ii) shows how these regions may shift when 8 is increased, and is drawn under the assumption that the supply curve retains its Case-1 shape. From lines (i) and (ii), it is clear that wages that started out in Regions 1 and 2 remain there after the increase in 8. However, the wages that identify the lower bounds of Regions 3 and 4 rise. As a result, some wages that were originally in the Region-3 range may now be in Region 4 (shown in Figure A1) or even Region 5 (not shown in Figure A1).

Under our assumptions about the production function f(L), $2(L_M;R)$ is continuous and decreasing in 8. It follows that *for some parameter values*, a sufficiently large $)8 > 0$ could cause the labor supply curve to switch from a Case-1 shape to a Case-2 shape. The implications for the regions of the labor supply curve are shown in (iii) in Figure A1. Wages that started out in Region 2 may be in Region 3* after 8 increases. The implications for wages that started out in Regions 4 and 5 are the same as in line (ii).

Inspection of Figure A1, and keeping in mind that increasing 8 increases $S\&2(L)$, we arrive at the following taxonomy: following an increase in 8,

(1) if w^A started out in Region 1, then it remains in Region 1.

(2) If w^A started out in Region 2, then it may
   (a) remain in Region 2, or
   (b) become a Region-3* wage (if there is a change to Case 2).

(3) If w^A started out in Region 3, then it may
   (a) remain in Region 3 (Case 1),
   (b) become a Region-4 wage, or
   (c) become a Region-5 wage.

(4) If w^A started out in Region 4, then it may
   (a) remain in Region-4 or
   (b) become a Region-5 wage.

(5) If w^A started out in Region 5, then it remains in Region 5.

Now we are in a position to say how labor supply is affected by an increase in λ. If w^A started out in Region 1, then an increase in the proportion of dividend-earning households (λ)will have no effect on child labor, since even the no-dividend families have no child labor. $\Delta L = 0$.

If w^A started out in Region 2, then labor supply decreases as the proportion of dividend-receiving households increases: in this region, wages are high enough to keep dividend-household children out of the labor force, so reducing the proportion of no-dividend households automatically reduces child labor. A sufficiently large $\Delta\lambda$, however, may move some dividend-household children into the labor force (w^A is in Region 2, Case 1, but is in Region 3*, Case 2 when λ increases) by diluting dividend payments. The net effect on total employment is shown in equation (A2.1):

$$\Delta L = -N\frac{S-(1-\gamma m)w^A}{2w^A}\Delta\lambda + \max\left[0,\ \lambda_1 N\frac{S-(1-\gamma m)w^A-\theta_1}{2w^A}\right] \tag{A2.1}$$

The first term in equation (A2.1) is negative for all $\Delta\lambda > 0$, since $S/(1-\gamma m) > w^A$. This is the decrease in child labor due to the increase in the number of dividend-earning households (the new dividend households withdraw all of their children from the labor force). The second term equals zero when $[S-\theta_1]/(1-\gamma m) \leq w^A$: in this case, w remains in Region 2 after the increase in λ. The second term is positive when $[S-\theta_1]/(1-\gamma m) > w^A$: in this case w^A is in Region 3* (Case 2) after the increase in λ. The term $\lambda_1 N[S-(1-\gamma m)w^A-\theta_1]/2w^A$ in equation (A2.1) equals the total number of (adult-equivalent) children from dividend families who are in the labor force after the change in λ. The net effect on L is negative throughout this Region: if w^A remains a Region-2 wage rate after λ rises, then ΔL is clearly less than zero. If w^A becomes a Region-3* wage rate, then, from equation (A2.1),

$$\begin{aligned}\Delta L &= -N\frac{S-(1-\gamma m)w^A}{2w^A}\Delta\lambda + \lambda_1 N\frac{S-(1-\gamma m)w^A-\theta_1}{2w^A} \\ &= \frac{N}{2w^A}\left[\lambda_0[S-(1-\gamma m)w^A-\theta_0] - \lambda_1\theta_1 + \lambda_0\theta_0\right]\end{aligned} \tag{A2.2}$$

$S\&(1\&(m)w^{A}\&2_0 < 0$ by virtue of the fact that $w^{A} > [S\&2_0]/(1\&(m)$ for w^A in Region 2. Recalling that dividends are defined as $2\,'\,[f(L;R)\&L M f(L;R)/ML]/8N \;/\; B(L;R)/8N$, we see that $\&8_1 2_1\%8_0 2_0 = (1/N)(B(L_0;R)\&B(L_1;R))$ is positive when $L_0 > L_1$ and negative when $L_1 > L_0$. To see that $8_0[S\&(1\&(m)w^{A}\&2_0]\&8_1 2_1\%8_0 2_0$, the bracketed term in equation (A2.2), is unambiguously negative, we proceed by establishing a contradiction when $)L$ is assumed to be positive or zero.

Suppose $)L$ were positive, i.e., that $L_1 > L_0$: then, $\&8_1 2_1 \% 8_0 2_0$ would be negative. The bracketed term on the right-hand side of equation (A2.2) would then be the sum of two negative numbers, which contradicts the assumption that $)L > 0$.

Suppose $)L$ were zero, i.e., that $L_0 = L_1$: then, $\&8_1 2_1 \% 8_0 2_0$ would also equal zero, and the right-hand side of equation (A2.2) would be strictly negative, which contradicts the assumption that $)L = 0$.

We conclude that employment (child labor) falls in response to an increase in 8 when w^A starts out in Region 2.

If w^A started out in Region 3, then

$$)L \;'\; \&N(m)8\%\max\left[0,\ \min\left[N8_1\frac{S\&(1\&(m)w^{A}\&2_1}{2w^{A}},\ N8_1(m\right]\right] \tag{A2.3}$$

The first term in equation (A2.2) is the decrease in labor supplied when the $N)8$ new dividend households withdraw their children from the labor force. If $[S\&2_1]/(1\&(m) < w^{A}$ (w^A remains in Region 3) , then the second term in equation (A2.2) equals zero. If dividends fall by enough that $[S\&2_1]/(1\%(m) < w^{A} < [S\&2_1]/(1\&(m)$, then w^A is in Region 4 of the new labor supply curve. In this case, all dividend households put some of their children into the labor market and the net $)L$ could be positive, negative, or (a knife-edge case) zero. Finally, dividends could sink low enough that all dividend households put all of their children into the labor market. Then, $)L\,'\,\&N(m)8\%N8_1(m\,'\,N8_0(m$.

If w^A started out in Region 4, then

$$)L \;'\; N\frac{S\&(1\%(m)w^{A}\&2_0}{2w^{A}})8\%\frac{8_1 N}{2w^{A}}\min\left[2_0\&2_1,\ \&S\%(1\%(m)w^{A}\%2_0\right] \tag{A2.4}$$

The first term in equation (A2.4) equals the decrease in child labor among the newly-minted dividend households, *at a given level of dividends*. It has the same interpretation as the first terms in equations (A2.1) and (A2.3). The second term, which is positive, is the increase in employment among all dividend households due to the decrease in dividends. $2_0\,\&\,2_1 < \&S\%(1\%(m)w^{A}\%2_0$ if w^A remains in Region 4 (i.e., $w^A > [S\&2_1]/(1\%(m)$). $\&S\%(1\%(m)w^{A}\%2_0 < 2_0\,\&\,2_1$ if w^A becomes a Region-5 wage after the increase in 8.

Although $)L$ is the sum of a positive and a negative term, it is straightforward to show that the net effect of an increase in 8 on L is unambiguously positive. Consider first the possibility that w^A remains in Region 4. Then,

$$\Delta L = N\frac{S-(1+\gamma m)w^A-\theta_0}{2w^A}\Delta\lambda + \frac{\lambda_1 N}{2w^A}(\theta_0-\theta_1) \tag{A2.5}$$

$$= \frac{N}{2w^A}\Big[[S-(1+\gamma m)w^A]\Delta\lambda + \lambda_0\theta_0 - \lambda_1\theta_1\Big]$$

In equation (A2.5), $S-(1+\gamma m)w^A > 0$, since $w^A < S/(1+\gamma m)$. We can now use an argument similar to the one used above to sign the right-hand side of equation (A2.2), to establish that ΔL must be positive.

Suppose ΔL were negative, i.e., that $L_0 > L_1$: then, $-\lambda_1\theta_1 + \lambda_0\theta_0$ would be positive. The right-hand side of equation (A2.5) would then be the sum of two positive numbers, which contradicts the assumption that $\Delta L < 0$.

Suppose ΔL were zero, i.e., that $L_0 = L_1$: then, $-\lambda_1\theta_1 + \lambda_0\theta_0$ would also equal zero, and the right-hand side of equation (A2.2) would be strictly positive, which contradicts the assumption that $\Delta L = 0$.

We conclude that employment (child labor) rises in response to an increase in λ when w^A starts out in, and remains in, Region 4.[35] Now suppose that although w^A started out in Region 4, it becomes a Region-5 wage following the increase in λ. Then, from equation (A2.4),

$$\Delta L = N\frac{S-(1+\gamma m)w^A-\theta_0}{2w^A}\Delta\lambda - \frac{\lambda_1 N}{2w^A}[S-(1+\gamma m)w^A-\theta_0]$$

$$= -\frac{\lambda_0 N}{2w^A}[S-(1+\gamma m)w^A-\theta_0] \tag{A2.6}$$

which is positive since $[S-\theta_0]/(1+\gamma m) < w^A$ (w^A started out in Region 4). In sum, labor supply (and child labor) increases throughout Region 4, as more dividend families are created but each sends more children into the labor market (dividends are diluted).

If w^A starts out in Region 5, then child labor is already at a feasible maximum.. $\Delta L = 0$.

Case 2: $S/(1+\gamma m) > [S-\theta(L_M;\Omega)]/(1-\gamma m)$

As for Case 1, if w^A started out in Region 1, then $\Delta L = 0$. If w^A started out in Region 2, then it may remain in Region 2 or become a Region-3* wage, following the increase in λ. It is easy to verify that the net change in L is exactly the same as in equation (A2.1), for Case 1.

If w^A starts out in Region 3*, then the change in λ has no effect on the labor supply curve. To see this, note first that if w^A starts out in Region 3*, then it remains in Region 3* after λ increases, and

$$\Delta L = -\frac{\theta_1\Delta\lambda N}{2w^A} + \frac{\lambda_0 N(\theta_0-\theta_1)}{2w^A} \tag{A2.7}$$

---

[35] A more direct way to see this is to differentiate the labor supply curve (assuming w^A remains in Region 4 following the change in λ):
$\partial L/\partial\lambda = N[S-(1+\gamma m)w^A]/[2w^A - L\partial f^2(L;\Omega)/\partial L^2] > 0$.

The first term in equation (A2.7) is the decrease in labor supplied by newly-minted dividend households. The second term is the increase in labor supplied by "old" dividend households when dividends fall. Some algebra shows that

$$\Delta L = -\frac{\theta_1 N \Delta\lambda}{2w^A} + \frac{\lambda_0 N(\theta_0 - \theta_1)}{2w^A} = N\frac{\lambda_0\theta_0 - \lambda_1\theta_1}{2w^A} \tag{A2.8}$$

$\lambda_0\theta_0 - \lambda_1\theta_1$ is positive when ΔL is negative and negative when ΔL is positive (which is contradictory), and equals zero when $\Delta L = 0$.[36]

If w^A starts out in Regions 4 or 5, the results are identical to the Case 1 situation.

[36]A more direct way of seeing this is to look at the Region 3* supply expression in Table A2, and to notice that λ enters the labor supply expression only through the term $\lambda\theta$. But $\lambda\theta$ = $(1/N)[f(L;R)-L\partial f(L;R)/\partial L]$, which does not depend on λ.

TABLE 1: Critical Wages for Labor Supply

w^{A} equals		critical w^{A} if w^{C} = $(w^{A}$
$S\%mw^{C}$	the wage at which no-dividend children begin to work	$\frac{S}{1\&(m}$
$S\&mw^{C}$	the wage at which all no-dividend children are employed	$\frac{S}{1\%(m}$
$S\%mw^{C}\&2$	the wage at which dividend children begin to work	$\frac{S\&2}{1\&(m}$
$S\&mw^{C}\&2$	the wage at which all dividend children are employed	$\frac{S\&2}{1\%(m}$

Table 2

Tobit Estimates with EAP90 as Dependent Variable

	(1)				(2)			
	b	**b/s.e.**	**mean**		**b**	**b/s.e.**	**mean**	
Overall								
Constant	53.43	4.12			48.65	4.37		
RGDPW	-1.51	-4.87	11.71		-1.13	-3.89	12.61	
RAWGINI	0.26	1.69	41.50					
RAWQ5Q1					0.20	1.05	10.15	
CHILDADU	2.60	0.47	0.87		7.02	1.38	0.84	
QUESAGE	-3.77	-3.51	11.97		-3.29	-3.40	12.13	
Sigma	11.36	10.82			9.98	10.07		
N				88				79
Lower Sub-Sample								
Constant	120.29	4.93			75.80	4.56		
RGDPW	-8.72	-5.77	2.41		-3.48	-5.82	4.57	
RAWGINI	-0.10	-0.59	44.29					
RAWQ5Q1					0.32	1.69	11.66	
CHILDADU	13.72	1.45	1.09		2.27	0.35	1.04	
QUESAGE	-7.85	-3.46	10.35		-4.52	-3.56	10.69	
Sigma	8.33	7.77			8.58	8.68		
N				31				42
RGDPW at Split Point				5.02				10.01
Upper Sub-Sample								
Constant	20.41	2.74			11.89	2.33		
RGDPW	-0.26	-1.28	16.76		0.02	0.13	21.74	
RAWGINI	0.38	3.68	39.99					
RAWQ5Q1					0.58	4.35	8.44	
CHILDADU	1.29	0.41	0.75		3.52	1.58	0.61	
QUESAGE	-2.61	-4.28	12.84		-1.55	-3.15	13.76	
Sigma	5.62	7.59			2.98	4.98		
N				57				37
Chi-Square				58.85				41.13

Notes: RGDPW is measured in 1000s. Likelihood ratio tests indicated no multiplicative heteroscedasticity in any sample.

Table 3

OLS Estimates with GROSSSEC as Dependent Variable

	(1)				(2)			
				Overall				
	b	**b/s.e.**	**mean**		**b**	**b/s.e.**	**mean**	
GROSSSEC			56.25				61.00	
Constant	71.25	5.60			70.91	6.57		
RGDPW	1.69	6.17	12.27		1.37	4.82	13.41	
RAWGINI	-0.40	-1.72	40.49					
RAWQ5Q1					-0.15	-0.42	9.41	
CHILDADU	-23.41	-2.57	0.83		-33.89	-3.57	0.79	
N				75				67
				Lower Sub-Sample				
GROSSSEC			17.68				23.30	
Constant	9.17	0.66			19.13	1.14		
RGDPW	23.55	5.62	1.64		20.59	3.09	1.83	
RAWGINI	0.02	0.11	44.17					
RAWQ5Q1					0.09	0.21	9.70	
CHILDADU	-29.69	-3.19	1.05		-32.38	-3.00	1.06	
N				16				10
RGDPW at Split Point				2.40				2.40
				Upper Sub-Sample				
GROSSSEC			66.72				67.61	
Constant	87.33	6.58			78.94	6.76		
RGDPW	1.13	3.91	15.15		1.08	3.50	15.44	
RAWGINI	-0.45	-1.82	39.50					
RAWQ5Q1					-0.33	-0.88	9.35	
CHILDADU	-26.10	-2.86	0.77		-33.27	-3.30	0.75	
N				59				57
Chi-Square				45.45				23.74

Notes: For vertical panel (2), the results presented are for the third best split, as the first two best splits contained only the minimum number of observations (5) needed to obtain estimates of the parameters. See text for further explanation. RGDPW is measured in 1000s. White's tests indicated no heteroscedasticity in any sample.

Table 4
OLS Estimates with GROSSPRI as Dependent Variable

	(1)				(2)			
			Overall					
	b	**b/s.e.**	**mean**		**b**	**b/s.e.**	**mean**	
GROSSPRI			93.15				96.12	
Constant	81.52	5.69			106.82	9.92		
RGDPW	0.67	2.15	12.26		0.08	0.31	13.34	
RAWGINI	0.29	1.18	40.71					
RAWQ5Q1					0.57	1.93	9.48	
CHILDADU	-9.97	-0.97	0.83		-21.53	-2.20	0.80	
N				80				71
			Lower Sub-Sample					
GROSSPRI			80.41				86.74	
Constant	94.97	3.10			136.58	5.89		
RGDPW	5.69	2.22	2.96		1.20	0.50	3.37	
RAWGINI	0.28	0.61	43.20					
RAWQ5Q1					0.35	0.47	9.54	
CHILDADU	-41.59	-2.02	1.05		-54.67	-3.06	1.05	
N				34				27
RGDPW at Split Point				6.85				6.85
			Upper Sub-Sample					
GROSSPRI			102.57				101.89	
Constant	87.55	10.16			94.03	13.85		
RGDPW	0.16	0.88	19.14		0.13	0.74	19.45	
RAWGINI	0.19	1.18	38.87					
RAWQ5Q1					0.29	1.31	9.45	
CHILDADU	6.51	1.18	0.68		3.95	0.68	0.65	
N				46				44
Chi-Square				69.08				47.31

Notes: White's tests indicated heteroscedasticity in the "overall" samples. The affected standard errors were corrected.
RGDPW is measured in 1000s.

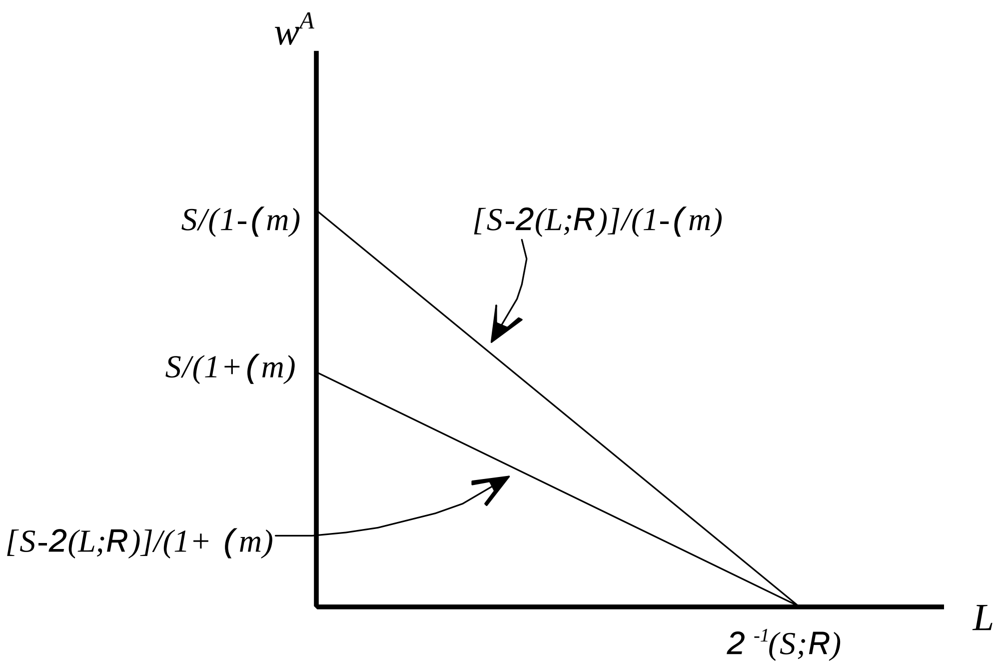

FIGURE 1

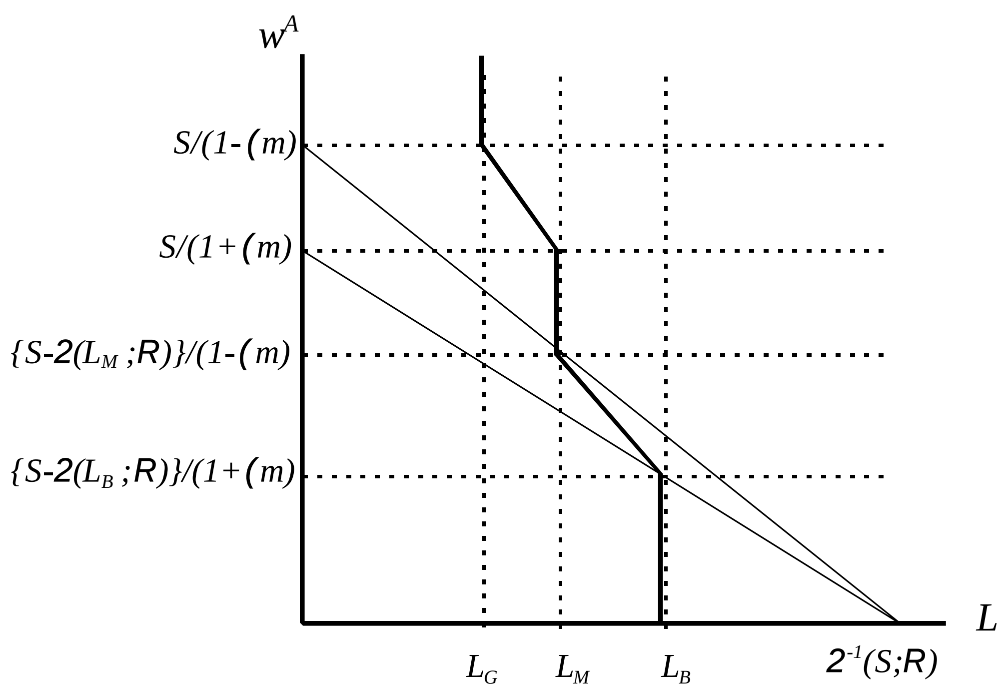

FIGURE 2

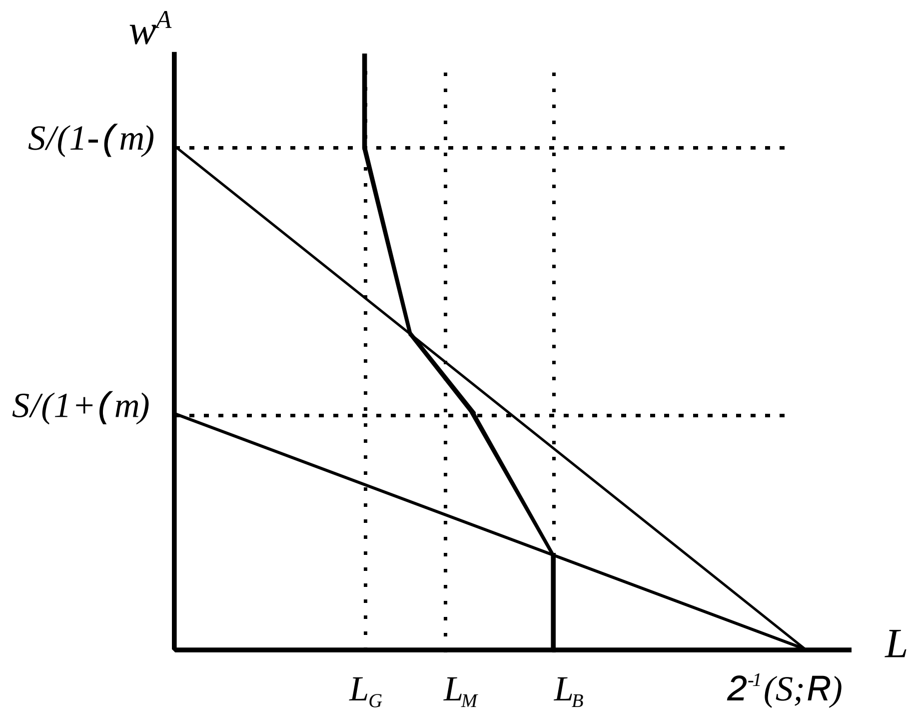

FIGURE 3

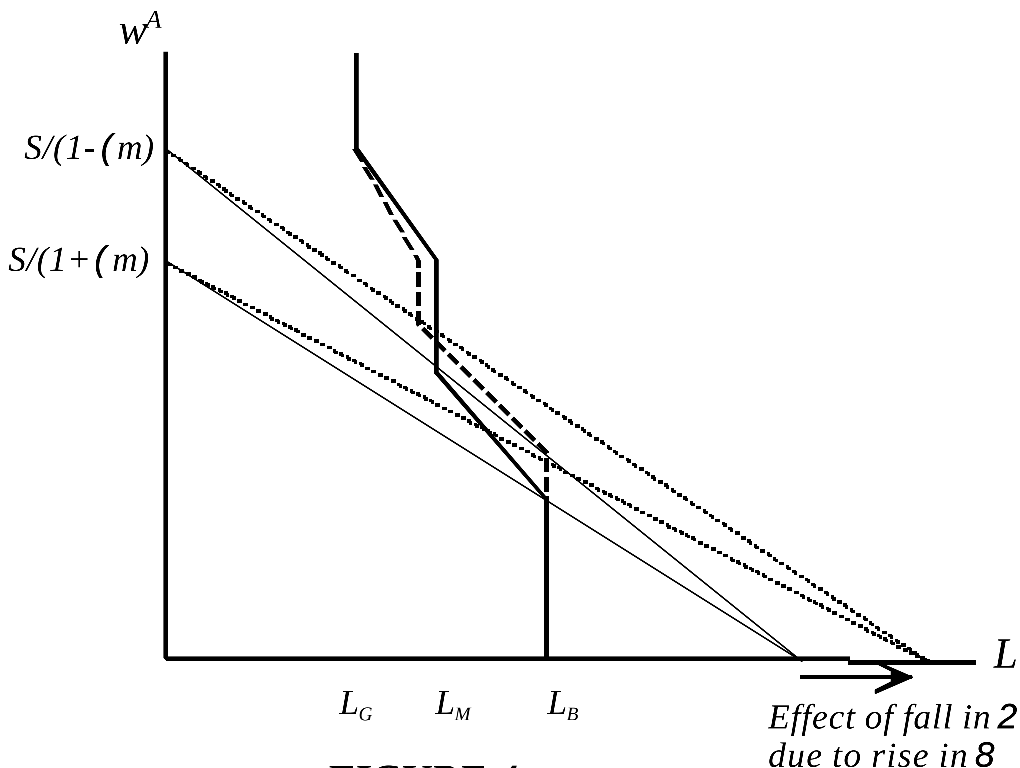

FIGURE 4

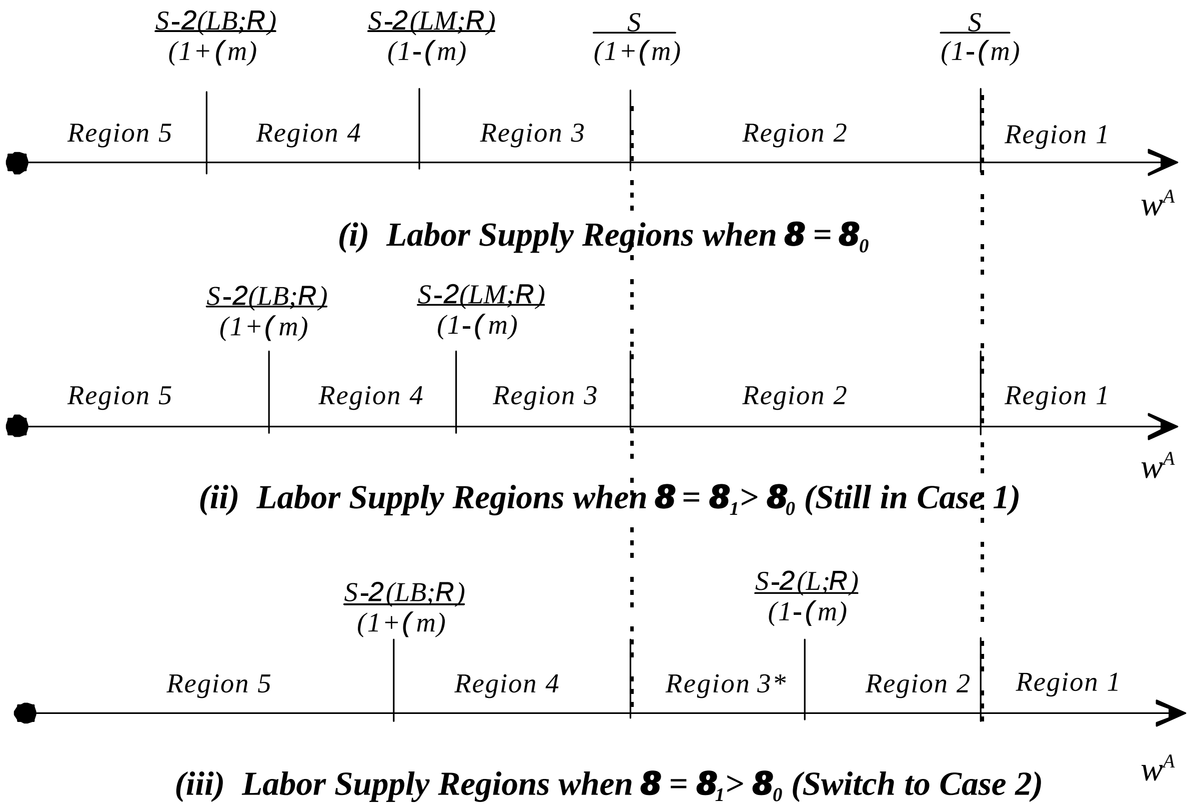
S-2(LB;R) / (1+(m)
S-2(LM;R) / (1-(m)
S / (1+(m)
S / (1-(m)
Region 5
Region 4
Region 3
Region 2
Region 1
w^A
(i) Labor Supply Regions when 8 = 8_0
S-2(LB;R) / (1+(m)
S-2(LM;R) / (1-(m)
Region 5
Region 4
Region 3
Region 2
Region 1
w^A
(ii) Labor Supply Regions when 8 = 8_1> 8_0 (Still in Case 1)
S-2(LB;R) / (1+(m)
S-2(L;R) / (1-(m)
Region 5
Region 4
Region 3*
Region 2
Region 1
w^A
(iii) Labor Supply Regions when 8 = 8_1> 8_0 (Switch to Case 2)

FIGURE A1

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